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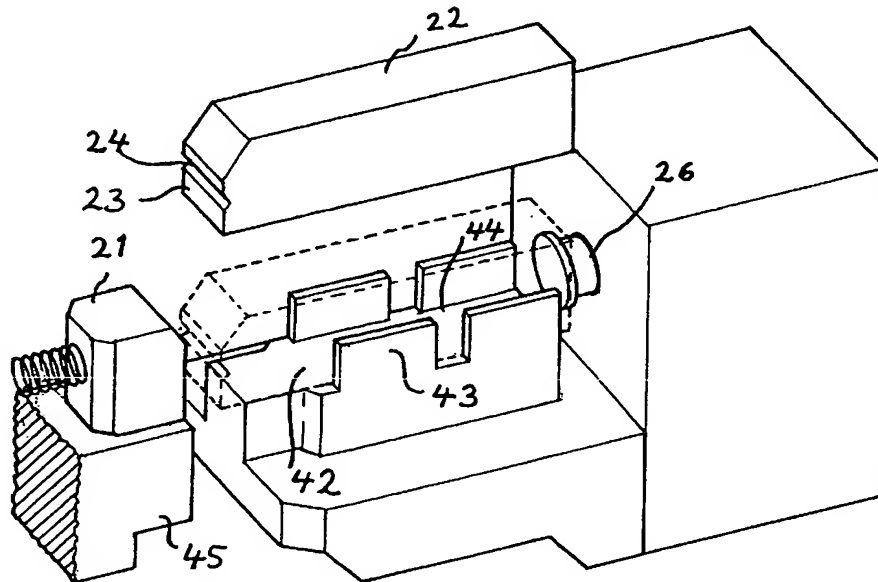
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(54) Title: AN ARRANGEMENT AND A METHOD FOR CLAMPING THIN RODS



(57) Abstract: An arrangement for clamping thin rods of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping locations for holding a said rod extended between the two clamping locations. The arrangement also comprises first clamping means arranged to clamp the rod in a first clamping location. The first clamping means has a first clamping member (22) with a clamp face (23) of substantially V-groove type for receiving the rod in the groove (24). The first clamping member is movably arranged with respect to a framework (45) of the apparatus for clamping a rod.

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***An arrangement and a method for clamping thin rods***

10 TECHNICAL FIELD OF THE INVENTION AND PRIOR ART

The present invention relates to an arrangement for clamping thin rods of glass or quartz (silica) having a diameter below 1 mm as well as a method for carrying out such a clamping according to the preambles of the appended independent arrangement and method claims.

Such an arrangement may be used to clamp and hold most varying types of rods for many different purposes, for instance an optical fibre for stripping or washing the fibre or for cleaving thereof. Although the invention is in general directed to clamping such thin rods of glass or quartz for any purpose, the invention and the problem to be solved thereby will hereinafter by way of a non-limitative example be discussed for the case of clamping optical fibres to be cleaved.

Optical fibre ends are commonly prepared for a variety of purposes (jointing, characterization etc) by a process known as cleaving. In such a process, a blade prepared from a hard material, such a diamond, is brought into a lateral engagement with the fibre to be cleaved in such a manner as to initiate a fracture which subsequently propagates through the fibre cross-section until the fibre parts. The resulting cleaved fibre end surface should, as far as possible, be optically flat and perpendicular to the fibre longitudinal axis. Undue intrusion of the blade into the

fibre during the cleaving process can damage the fibre so as to detract from the quality of the resulting end surfaces.

5 An arrangement according to the preambles of claims 1 and 2 is already known through US patent 4 790 465 disclosing an apparatus for cleaving optical fibres. Although the apparatus of US patent 4 790 465 may be used for obtaining comparatively high quality cleaved fibre end surfaces there is of course always a  
10 desire to improve such an apparatus with respect to both the cleaving result and the construction and by thereby the costs for manufacture and operation thereof. The present inventors have realized that it should be possible to obtain such an improvement by modifying said first clamping means of said arrangement. The clamping member with a clamp face of substantially  
15 V-groove type has to be occasionally exchanged, for example for adapting this clamping means to clamp a fibre with another diameter than the fibre cleaved in said apparatus before or for exchanging a clamping member having the V-groove worn out or damaged. This exchange takes in the apparatus according to US  
20 patent 4 790 465 a considerably long period of time resulting in substantially costs as a consequence of a reduced efficiency of the apparatus. The reason for this is that a considerably amount of work is required for removing said first clamping member from the apparatus.

25 Another disadvantage of the arrangement of the apparatus according to US patent 4 790 465 is that one of the two members of the first clamping means, namely the one having said flat opposing clamp face, is pivoted with respect to the other clamping  
30 member of said first clamping means for clamping an optical fibre located in the groove, and this means that there is an inherent risk of applying torsional stress to the fibre through said clamping action. Although it is stated in said US patent that the fibre is not rotated when the clamping means closes, the risk of  
35 influencing the fibre in the direction of such a rotation shall not be neglected due to the presence of said pivoting movement.

Torsional stress applied to a fibre during cleaving can cause the cleave to propagate across the fibre at an angle of up to 45° with respect to the fibre axes, rather than 90° as desired.

## 5 SUMMARY OF THE INVENTION

An object of the present invention is to provide an arrangement of the type defined in the preamble of claim 1 having a higher efficiency discussed above than such arrangements already  
10 known.

This object is according to the invention obtained by providing such an arrangement having the characteristics that the first clamping member is movably arranged with respect to a frame-  
15 work of the arrangement, and that the arrangement further comprises driving means for moving the first clamping member having the grooved clamp face towards and away from the second clamping member for clamping and releasing a said rod, respectively.

20 By arranging said substantially V-groove in a movable clamping member of said first clamping means and not in one being fixed to a framework of the apparatus, it will be easy to remove the first clamping member for exchanging it by another first clamp-  
25 ing member having a groove being differently designed or for replacing a first clamping member being worn out or damaged by a new one. Thus, the efficiency of the arrangement may be raised.

30 Another object of the present invention is to provide an arrangement of the type defined in the preamble of appended claim 2 reducing the risks of applying torsional stress to a rod clamped by said first clamping means with respect to the arrangement according to the US patent mentioned above.

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This object is according to the invention obtained by providing such an arrangement having the characteristic that it further comprises driving means adapted to move at least one of said clamping members for creating a rectilinear relative movement of said clamping members towards and away from each other for clamping and releasing a said rod, respectively.

By arranging the members so that they will carry out a rectilinear relative movement for clamping a rod the risks of applying torsional stress to a rod being clamped will be reduced remarkably with respect to the case of arranging one of the members pivoted with respect to the other.

According to a preferred embodiment of the invention said clamping member being movable for clamping and releasing a said rod is received in a guide of the apparatus and removable from the apparatus by pushing and/or lifting it out of the guide for exchange. This means a remarkable improvement with respect to the apparatus of the US patent discussed above concerning the time consumption of exchange of the clamping member being provided with the groove, in the case that the first clamping member is movable, and it also means a possibility to obtain said rectilinear relative movement in a favourable way in the case that the clamping members are moved in a rectilinear relative movement for clamping a rod.

According to another preferred embodiment of the invention the guide is constituted by a slot having a bottom on which said clamping member is intended to rest and lateral walls intended to guide the clamping member in said movement, and the clamping member is removable from the apparatus by lifting it out of the guide. This means that this clamping member may very rapidly be removed and replaced by a new one. It is then especially preferred if the movable clamping member comprises a block-like piece resting only through gravity in said guide, and this block-like piece has preferably a considerable weight with

respect to other parts of the arrangement for reliably resting in said guide.

5 According to another preferred embodiment of the invention the arrangement further comprises at least one member having at least one inclined surface and means for moving said member laterally towards a rod being clamped in only a second of said two clamping locations for clamping it in the first clamping location through said first clamping means with the inclined surface  
10 into abutment against the rod for influencing the rod by sliding thereof upon said surface for reaching the position desired for said first clamping location before clamping the rod in that location. The existence of such a member moving the rod into the desired position before the rod is clamped in said first clamping  
15 location means that the clamping action may be carried out while reducing the risk of the rod being not correctly located when clamped and by this being twisted by said clamping action, which for example would degrade the quality of a future cleaved end surface as discussed above.

20 The arrangement also comprises an apparatus for cleaving thin rods of glass or quartz according to the appended independent apparatus claim. According to a preferred embodiment said arrangement of such an apparatus comprises a second clamping  
25 means arranged to clamp said rod in a second said clamping location, the second clamping means is movable in the longitudinal direction of a said rod extended between the two clamping locations, the apparatus comprises means for moving the second clamping means in said longitudinal direction for extending  
30 a rod clamped by said arrangement for applying a longitudinal tension load to the rod, and the second clamping means is adapted to clamp said rod in a second said clamping location belonging to the part of a cleaved rod intended for later use. This means that there is a possibility to use the power applying  
35 the tension load to move the cleaved end surface away from the cleaving point immediately when the rod parts, so that there will

be no risk of damaging this end surface by further contact with the blade after the cleaving instant. This is also the subject of another preferred embodiment of the invention. Such an embodiment is particularly advantageous in the case of having an apparatus with a body carrying the blade and driving means adapted to act upon said body for causing a relatively steady movement of the blade towards said desired cleaving point while subjecting the blade to a relatively small-amplitude vibratory component of movement towards and away from said cleaving point superimposed to said relatively steady movement towards the cleaving point, since this then means that there will be no risk that the vibrating blade will hit the rod once again after the rod has been cleaved.

The invention also relates to methods of clamping a thin rod according to the appended independent method claims. The advantages of such methods and the embodiments thereof according to the appended dependent method claims appear without any doubt from the above discussion of the preferred embodiments of the arrangement according to the present invention.

The invention also relates to a computer program and a computer readable medium according to the corresponding appended claims. It is easily understood that the methods according to the invention defined in the appended set of method claims are well suited to be carried out through instructions from a processor that may be influenced by a computer program provided with the program steps in question.

Further advantages as well as advantageous features of the invention appear from the following description and the other dependent claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

With reference to the appended drawings, below follows a specific description of a preferred embodiment of the invention cited as an example.

5 In the drawings:

- 10 Fig 1 is a perspective view of an apparatus according to a preferred embodiment of the invention in an initial state of a cleaving sequence of loading the apparatus with a thin rod, such as an optical fibre, to be cleaved,
- 15 Fig 2 is a view corresponding to fig 1 of the apparatus in a state of said cleaving sequence in which the thin rod has been clamped in two mutually-spaced clamping locations,
- 20 Fig 3 is a simplified side-elevation of a part of a clamping arrangement of the apparatus according to fig 1 illustrating the means for clamping the rod in one of said clamping locations and adjusting the height of the rod to be clamped there more in detail,
- 25 Fig 4 is a simplified side-elevation mainly illustrating a first clamping means of the apparatus according to Fig 1,
- 30 Fig 5 is a perspective view of the first clamping means illustrated in Fig 4 showing how easily a first clamping member thereof may be exchanged,
- 35 Fig 6 is a simplified view illustrating how the means for clamping said rod in the other clamping location may be moved for moving said clamping location in the longitudinal direction of the rod,



- Fig 7 is a simplified perspective view illustrating the body carrying the rod cleaving blade and the driving means used to perform the cleaving operation,
- 5 Fig 8 is a simplified perspective view of said rod cleaving blade and the body carrying the blade illustrating the principal of achieving the cleaving movements of the blade,
- 10 Fig 9 is a simplified view from above of a part of the apparatus according to fig 1 in a state of the cleaving sequence in which the vary cleaving has already been carried out, and
- 15 Fig 10 is a view corresponding to fig 9 of the step of said cleaving sequence following directly upon the state illustrated in fig 9.

## 20 DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT OF THE INVENTION

Fig 1 illustrates an apparatus for cleaving thin rods of glass or quartz, preferably optical fibres, having a diameter below 1 mm, and preferably in the range of 50  $\mu\text{m}$  – 200  $\mu\text{m}$ . The optical fibre is clamped in a second clamping means 1 in the form of a conventional fibre holder used for holding a fibre also when joining two optical fibres, and this is already known. It is schematically illustrated in fig 2 by dashed lines how a lid 2 of said clamping means may be pivoted for opening and closing this clamping means. This clamping means 1 is adapted to hold the fibre to be cleaved with a part 3 on which the cleaving is to be carried out projecting out from the fibre holder.

35 The apparatus also comprises a member 4 adapted to receive the fibre holder 1 therein for holding it in a well-defined position during the cleaving sequence. The receiving member 4 has the

character of a carriage with a bottom 5 onto which the fibre holder is intended to rest and guiding members 6 in the form of pins for laterally supporting the fibre holder in a well defined position on the carriage 4. The carriage has also a front member 7 extending upwardly from the bottom 5 and defining the position of the fibre holder in the longitudinal direction of a fibre held therein. This front member 7 has a central slot 8 extending therethrough and opening upwardly for receiving the free fibre part 3 therein. The carriage 4 is moveable in the longitudinal direction of a fibre in a fibre holder received therein and in the longitudinal direction of a rail 9 in a way to be described further below.

This construction of said receiving member 4 is very favourable with respect to the loading of a fibre to be cleaved in the apparatus. This loading action takes place in the following way. The fibre holder 1 with a fibre clamped therein and a part 3 to be cleaved projecting out therefrom is placed in the position shown in fig 1 with the front portions of the fibre holder 1 resting upon the upper surfaces 10 of the front member 7. The guiding pins 6 will define the correct direction of the fibre holder. The fibre holder 1 is then retracted, so that it will leave the support on the front member 7 and be lowered onto the bottom 5 of the receiving member 4 while being guided in a well defined movement through the guiding pins 6, and the part 3 of the fibre will move down in the slot 8 to the position shown in fig 2. This well controlled movement of the fibre part 3 means that there is no risk of damaging the fibre through contact with other members of the apparatus during this loading action.

Furthermore, the front member 7 and the bottom 5 of the carriage 4 are adapted to magnetically interact with the fibre holder 1 having for this sake magnets for keeping the fibre holder in a well defined position with the front end 11 thereof into contact with the front member 7.

It is illustrated in fig 6 how the carriage is fixed to the rail 9 with a screw 50. This is done for obtaining the correct cleaving length. Means 12 for moving the rail 9 and by that the carriage 4 in the form of a dc-motor is arranged to act between a fixed frame 45 of the apparatus and an arm 52 rigidly connected to the rail 9 for moving these parts in a linear bearing 53. The connection between the motor 12 and the carriage 4 includes means 13 in the form of a load cell for measuring the load applied through the motor onto the carriage. This means when the clamping part 3 is clamped in another clamping location downstream of the fibre holder 1 that the tension in said fibre may be influenced by the motor 12 and the magnitude of that tension load may be measured by the load cell 13. The apparatus also comprises means 41 for very accurately measuring the position of the carriage 4 and communicating with a computer 40 (see below).

The apparatus also comprises a member 14 adapted to adjust the position of the fibre part 3 in another of said two clamping locations thereof before the fibre is clamped in that location. This member 14 comprises for that sake two members 15 extending substantially in parallel with each other from a frame 16 and having each two inclined surfaces 17, 18, which are oppositely inclined with respect to a horizontal plane through the two clamping locations desired. Driving means 19, here driven by compressed air, is arranged to move the member 14 so that the fibre part 3 comes into abutment against one of the inclined surfaces of each member 15 for sliding thereupon and reaching the position desired for a clamping location of the fibre part 3 corresponding to a position of the fibre part in a seat of the members 15 in the intersection between the two inclined surfaces 17, 18 of each member 15. This means that the fibre part 3 is then in a well-defined position before it is clamped, so that it may be subsequently clamped without being damaged or exerted to torsion loads or the like.

It is further illustrated in fig 3 how a spring member 20 is counter-acting the driving means 19 while being arranged to act between a member 21 being fixed with respect to a frame work 45 of the apparatus and the frame 16 of the member 14, so that the member 14 will automatically be withdrawn from the fibre part when the influence of the driving means 19 thereupon is removed.

The apparatus also comprises a first clamping means adapted to clamp the fibre in one of said two mutually-spaced clamping locations, and this first clamping means comprises a first clamping member 22 with a clamp face 23 of substantially V-groove type, for receiving a fibre part 3 in a groove 24, and a second clamping member formed by said fixed member 21 having a flat opposing clamp face 25 for retaining the fibre in the groove. The apparatus comprises a driving means 26 driven by compressed air for moving said first clamping member 22 in the direction towards the second clamping member 21 for clamping a fibre. The first clamping member 22 is constituted by a block-like piece resting only by means of the gravitation on a surface in a guide 44 having a bottom 42 and lateral walls 43 intended to guide the clamping member 22 in its rectilinear movement towards and away from the second clamping member 22, so that it may easily be removed from the apparatus by lifting it out of the guide for exchange when the groove or the face portions adjacent thereto have been worn out or for replacing it by a first clamping member being designed for clamping rods with a different diameter. Thanks to this arrangement of a preferably comparatively heavy block-like piece 22 movable in said guide a movement being perfectly rectilinear without the slightest component deviating therefrom may be achieved. It is in Fig 5 shown how easily the piece 22 may be removed and put in place. Magnets may nevertheless be used to assist to keep the piece 22 even better in place when arranged in the guide 44.

The apparatus also comprises a rod cleaving blade 27 (see especially figs 5 and 6) adapted to be brought into lateral contact with the fibre at the desired cleaving point between said two clamping locations, to achieve cleaving of the fibre at said point.

5 This blade 27 is made of a hard material, such as diamond. The cleaving blade is carried by a body 28 comprising a strip-like stave having the blade 27 arranged on a free end 29 thereof and being fixed at the other end 30. This stave is made of a material varying its length through application of an electric field therein,  
10 i.e. a piezo-electric material.

The apparatus further comprising driving means adapted to act upon the stave for causing a relatively steady movement of the blade towards a desired cleaving point while subjecting the  
15 blade to a relatively small-amplitude vibratory component of movement towards and away from said cleaving point superimposed to said relatively steady movement towards the cleaving point. The arrangement of the blade on a free end of a stave means that said movements of the blade, both the relatively  
20 steady movement and the relatively small-amplitude vibratory component of movement, take place along an arc-like path and the blade will hit the fibre in a direction making an angle with the fibre differing from 90° for cutting the fibre in this direction. Accordingly, this path of these movements means that the blade  
25 will "scratch" the fibre when hitting it resulting in a cleaner score and fibre end surface than when just impacting the fibre perpendicularly thereto as in said US patent 4 790 465. This scratching action is further improved by arranging the blade on the free end of a projection 54 projecting from the stave towards  
30 the fibre at a distance from the stave. The movements are achieved in the way illustrated in fig 6 by applying a direct voltage through a direct voltage source 31 across the stave 28, the magnitude of which is controlled by a control means 32 for bending the free end of the stave 28 towards a fibre clamped in  
35 the apparatus. The driving means also comprises an alternating voltage source 33 adapted to apply an alternating voltage

across the stave 28 for generating said vibratory component of movement of the blade. Also the alternating voltage source is controlled by the control means 32. The alternating voltage applied to the stave has a frequency below 1 kHz and preferably below 750 Hz. In a particular embodiment the frequency is about 350 Hz. The peak to peak voltage of the alternating voltage may typically be in the order of 50 V, whereas the direct voltage may typically be varied from 0 to 100 V.

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- 10 The stave 28 is fixed to a frame 34 moveable with respect to the frame work of the apparatus through a step motor 35 in the vertical direction in steps of for example 50  $\mu\text{m}$  for controlling the position along the blade of the blade portion used for cleaving a fibre, so that this position may be changed for changing said
- 15 blade portion when a previous blade portion has been worn out, for example after carrying out about 1 000 cleaving operations while using the same blade portion therefor. This is preferably controlled by a computer program.
- 20 The rest of the constructional features of the apparatus according to the invention will now be explained while explaining the entire cleaving sequence of the apparatus:

- 25 The fibre holder 1 is firstly arranged in the carriage 4 in the way indicated in fig 1 and in the position shown in fig 2. A button is then pressed and the rest of the operation of the apparatus will take place automatically and preferably controlled by a computer 40 indicated in Fig 2. The dc-motor 12 will firstly move the carriage 4 so that the free end 36 of the fibre comes inside a small
- 30 tube 37 belonging to a device 38 adapted to draw a waist fibre portion 39 away through application of negative air pressure after the cleaving has been performed. After that the driving means 19 moves the members 15 towards the fibre for entering contact therewith through the inclined surfaces 17, 18 for ad-
- 35 justing the height of the fibre.

The driving means 26 is then pushing the first clamping member 22 of the first clamping means towards the fixed clamping member 21 for clamping the fibre in a first clamping location mutually-spaced from the second clamping location defined by the fibre holder 1. The action of the driving means 19 upon the member 14 is then removed, so that this member 14 is retracted through the action of the spring member 20. Said computer indicated through the dashed box 40 is then sending a signal to the means 12 for influencing the carriage 4 in the longitudinal direction of the fibre away from the second clamping location for applying a tension load to the fibre. The magnitude of this tension load is measured through the load cell 13 sending information thereabout to the computer 40. The tension load is in this way set to a value by the computer, for instance 1,5 N, but this value will change with the diameter of the fibre or the rod to be cleaved.

The driving means 35 is then controlled to move the blade 27 vertically to the desired position for the cleaving procedure. The control unit 32 does then control the direct voltage source 31 to gradually increase the direct voltage applied to the stave 28 for bending the stave, so that the blade 27 carries out a relatively steady movement towards the fibre. The control unit 32 controls at the same time the alternating voltage source 33 to apply an alternating voltage to the stave 28 for causing the blade 27 to vibrate towards and away from the fibre with a small amplitude in the order of 5-40  $\mu\text{m}$ , preferably in the range of 30  $\mu\text{m}$ . The blade 27 will in this way move with a velocity in the order of 1 mm/s towards the fibre while oscillating for cleaving the fibre. The low frequency of the vibration means that the blade 27 will move comparatively far in the direction towards the fibre in the period of time between two subsequent oscillations at a given, suitable velocity of said relatively steady movement. When for example this velocity is 1 mm/s and said frequency is 400 Hz this means an advancing distance of 2,5  $\mu\text{m}$  between subsequent "strikes" of the blade, which is much more than for the

blade in the US patent discussed in the introduction. This is a great advantage, since it means that the probability that the fibre parts already after being hit once by the blade is high and the fibre end surface resulting from the cleaving would be degraded by additional hits by the blade. The load cell 13 will indicate that the fibre has been cleaved through the disappearing of the tension load in the fibre. This information from the load cell will cause the control means 32 to stop the oscillation of the blade and remove the bending action thereupon. Furthermore the spring force in the load cell will automatically move the cleaved fibre end away from the blade immediately when the fibre parts.

The motor 12 is then controlled to move the carriage 4 slightly, in the order of 1 mm, away from the cleaving point for removing the cleaved end surface from the cleaving point as shown in fig 7. This movement will in fact be carried out automatically upon the cleaving of the fibre thanks to the favourable provision that the means 12 applying the longitudinal tension load to the fibre 3 is acting upon the carriage 4 and thereby the fibre holder 1 in the second clamping location belonging to the part of a cleaved rod intended for later use. This means that the valuable part of the fibre having the end surface aimed at by the cleaving action is efficiently immediately upon cleaving moved away from the cleaving point without any risk of being hit by the blade again after the cleaving moment. The driving means 19 is then controlled to move the member 14 to the position shown in fig 7 in contact with the waist fibre portion 39 resulting from the cleaving. The control means 32 influences then the direct voltage source 31 to move the blade 27 towards the waist fibre portion to laterally apply a force thereonto as shown in fig 7. The driving means 26 is then controlled to move the first clamping member 22 of the first clamping means away from the second clamping member 21 for releasing the waist fibre portion, and the tension caused therein by the blade will assist the waist fibre portion to



leave the groove 24 and be drawn away through the tube 37 by the device 38 for being disposed of.

5 The member 14 is retracted by shutting-off the pressurized air from the means 19, so that the spring 20 pushes the member 14 back. After that the control means 32 controls a withdrawal of the blade and the motor 35 returns the blade to the start position. The fibre holder 1 may now be removed for using the fibre end surface obtained through the cleaving process for joining or  
10 other purposes. The carriage 4 is moved to the "home" position by means of the dc-motor 12. The apparatus is now ready for cleaving a new fibre.

15 Studying the fibre end surfaces obtained by carrying out said cleaving process in the apparatus according to the present invention in interference microscope has shown that these end surfaces are of a very high quality, i.e. they are all within  $\pm 0,17^\circ$  from being exactly perpendicular to the fibre longitudinal axis.

20 The invention is of course not in any way restricted to the preferred embodiment described above, but many possibilities to modifications thereof will be apparent to a person with ordinary skill in the art without departing from the basic idea of the invention as defined in the appended claims.  
25

Although not necessary, it is well possible to use an anvil to support the fibre at the cleaving point.

30 The material of the body carrying the blade may just as well be of the type varying its length through application of magnetic fields, i.e. which has magneto-strictive properties, so that a relatively steady varying magnetic field and an alternating magnetic field may be used for generating the two superimposed  
35 movements of the blade according to the present invention.

"Relatively steady" as used for one of the movements of the blade is to be interpreted in relation to the vibratory component of movement, and does not restrict this movement to have a constant speed, but this may be changed during the movement, for example gradually decreasing or even gradually increasing.

"Relatively small-amplitude" with respect to the vibratory component of movement is to be interpreted as indicating that the amplitude of this movement is small with respect to the distance the blade is moving through said relatively steady movement thereof.

It is possible to replace the members having two inclined surfaces by members having each only one inclined surface and being moved from two opposite directions towards said rod.

Although it is spoken about fibre "height" adjustment and other words defining the orientation of the apparatus are used, these are to be interpreted as not restricting the scope of the present invention, but it would for example be possible to arrange the apparatus with the fibre clamped therein extending vertically.

"Rectilinear relative movement" as used in the claims of course also covers the case of moving both said clamping members at the same time. It would also be possible to move only the second clamping member having the substantially flat clamp face. Accordingly, this clamping member may be the one received in the guide or both clamping members may be received in a guide of the type discussed above.

The arrangement may have two or all clamping means designed as said first clamping means as defined in this disclosure.

The member having at least one inclined surface for guiding the rod into said groove may just as well be arranged on the first clamping member laterally thereof for being moved together

therewith, so that the same driving means may be used for these two members.

### Claims

1. An arrangement for clamping a thin rod (3) of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping  
5 locations for holding a said rod extended between the two clamping locations,

said arrangement comprising first clamping means arranged to clamp said rod (3) in a first said clamping location, said first  
10 clamping means having a first clamping member (22) with a clamp face (23) of substantially V-groove type, for receiving the rod in the groove (24), and a second clamping member (21) having a substantially flat opposing clamp face for retaining the rod in the groove,

15 ***characterized*** in that the first clamping member is movably arranged with respect to a framework of the apparatus and that the apparatus further comprises driving means for moving the first clamping member having the grooved clamp face towards  
20 and away from the second clamping member for clamping and releasing a said rod, respectively.

2. An arrangement for clamping a thin rod (3) of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping  
25 locations for holding a said rod extended between the two clamping locations,

said arrangement comprising first clamping means arranged to clamp said rod (3) in a first said clamping location, said first  
30 clamping means having a first clamping member (22) with a clamp face (23) of substantially V-groove type, for receiving the rod in the groove (24), and a second clamping member (21) having a substantially flat opposing clamp face for retaining the rod in the groove,

35

**characterized** in that the arrangement further comprises driving means (26) adapted to move at least one of said clamping members for creating a rectilinear relative movement of said clamping members (21, 22) towards and away from each other for clamping and releasing a said rod, respectively.

3. An arrangement according to claim 1 or 2, ***characterized*** in that said clamping member (22) being movable for clamping and releasing a said rod is received in a guide (44) of the apparatus and removable from the apparatus by pushing and/or lifting it out of the guide for exchange.

4. An arrangement according to claim 3, ***characterized*** in that guide is constituted by a slot (44) having a bottom (42) on which said clamping member is intended to rest and lateral walls (43) intended to guide the clamping member in said movement, and that the clamping member (22) is removable from the apparatus by lifting it out of the guide.

5. An arrangement according to claim 3 or 4, ***characterized*** in that movable clamping member comprises a block-like piece (22) resting only through gravity in said guide.

6. An arrangement according to any of the preceding claims, ***characterized*** in that one (21) of said clamping members is fixed with respect to a framework (45) of the apparatus.

7. An arrangement according to any of the preceding claims, ***characterized*** in that it further comprises at least one member (14) having at least one inclined surface and means for moving said member laterally towards a rod being clamped in only a second of said two clamping locations before clamping it in the first clamping location through said first clamping means with the inclined surface (17, 18) into abutment against the rod for influencing the rod by sliding thereof upon said surface for

reaching the position desired for said first clamping location before clamping the rod in that location.

5 8. An arrangement according to claim 7, **characterized** in that it comprises one or more said members (14) having together at least two said inclined surfaces (17, 18), which are oppositely inclined with respect to a plane including said two clamping locations and adapted to be moved by said moving means (19) laterally towards said rod for moving the rod to a seat in an intersection between said two inclined surfaces (17, 18) as seen  
10 in the direction from one clamping location to the other.

15 9. An arrangement according to claim 7 or 8, **characterized** in that said inclined surface (17, 18) or surfaces is (are) designed for adjusting the height of a said rod (3) at said first clamping location before the latter is clamped there.

20 10. An arrangement according to any of the preceding claims, **characterized** in that it comprises a second clamping means (1) arranged to clamp said rod in a second said clamping location, that the second clamping means is movable in the longitudinal direction of a said rod extended between the two clamping locations, that the apparatus comprises means (12) for moving the second clamping means in said longitudinal direction for extending a rod clamped by said arrangement for applying a longitudinal tension load to the rod (3).  
25

30 11. An arrangement according to claim 10, **characterized** in that it further comprises means (13) for measuring said tension load and means (40) for influencing said moving means (12) for adjusting the tension load on the basis of information about the tension load from said measuring means.

35 12. An arrangement according to claim 11, **characterized** in that said adjusting means comprises a computer (40) communicating

with the tension load measuring means (13) for adjusting said tension load to a value that may be set by the computer.

5 13. An arrangement according to any of the preceding claims, **characterized** in that it is adapted to hold optical fibres.

10 14. An arrangement according to any of the preceding claims, **characterized** in that it is adapted to hold said rods having a diameter below 600  $\mu\text{m}$ , below 300  $\mu\text{m}$  and preferably between 50 and 200  $\mu\text{m}$ .

15 15. An apparatus for cleaving thin rods (3) of glass or quartz having a diameter below 1 mm, comprising a rod cleaving blade (27), adapted to be brought into lateral contact with such a rod at a desired cleaving point between said two clamping locations, to achieve cleaving of said rod at said point, **characterized** in that it comprises an arrangement for clamping a said rod according to any of claims 1-14.

20 16. An apparatus according to claim 15, **characterized** in that it comprises an arrangement according to claim 10, and that the second clamping means thereof is adapted to clamp a said rod in a second said clamping location belonging to the part of the cleaved rod intended for later use.

25 17. An apparatus according to claim 16, **characterized** in that said means (12) for moving said clamping means (1) is adapted to automatically move the rod part clamped by said second clamping means away from the cleaving point upon cleaving of the rod as a consequence of said tension load applied there-through.

30 18. An apparatus according to any of claims 15-17, **characterized** in that it further comprises a body (28) carrying the blade and driving means adapted to act upon said body for causing a relatively steady movement of the blade towards said desired

cleaving point while subjecting the blade to a relatively small-amplitude vibratory component of movement towards and away from said cleaving point superimposed to said relatively steady movement towards the cleaving point.

5

19. An apparatus according to claim 18, *characterized* in that said body (28) is of a material varying its length through application of electric and/or magnetic fields therein, that said driving means is adapted to achieve said movements of the blade by influencing said body electrically and/or magnetically for creating length variations of the material thereof, and that the driving means is adapted to make the body and by that the blade vibrate with a said relatively small-amplitude component having a frequency below 1 kHz towards and away from the cleaving point for cleaving a said rod.

20. An apparatus according to claim 19, *characterized* in that said driving means is adapted to make the blade vibrate with a frequency below 750 Hz, between 100 and 700 Hz or between 250 and 450 Hz.

21. A method for clamping thin rods of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping locations for holding the rod extended between these two clamping locations;

in which said clamping is in a first clamping location carried out by creating a relative movement of a first clamping member (22) with a clamp face (23) of substantially V-groove type, for receiving the rod in the groove, and a second clamping member (21) having a flat opposing clamp face (25) for retaining the rod in the groove for clamping the rod,

*characterized* in that in said clamping said first clamping member (22) having the groove is moved towards the second clamp-



ing member (21) being fixed with respect to a framework (45) of an apparatus for cleaving said rods for clamping a said rod.

22. A method for clamping thin rods of glass or quartz having a diameter below 1 mm in two mutually-spaced clamping locations for holding the rod extended between these two clamping locations;

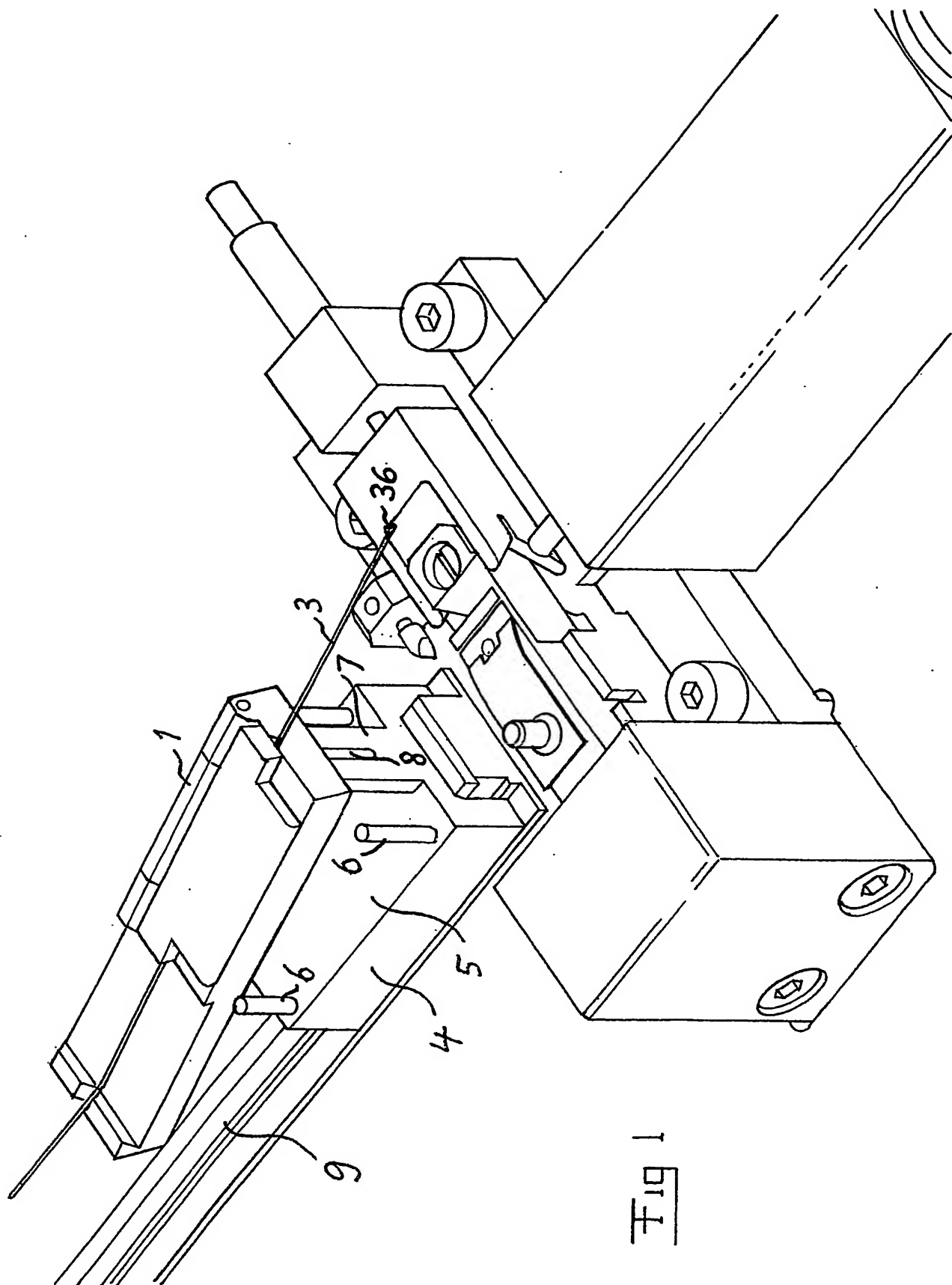
in which said clamping is in a first clamping location carried out by creating a relative movement of a first clamping member (22) with a clamp face (23) of substantially V-groove type, for receiving the rod in the groove, and a second clamping member (21) having a flat opposing clamp face (25) for retaining the rod in the groove for clamping the rod,

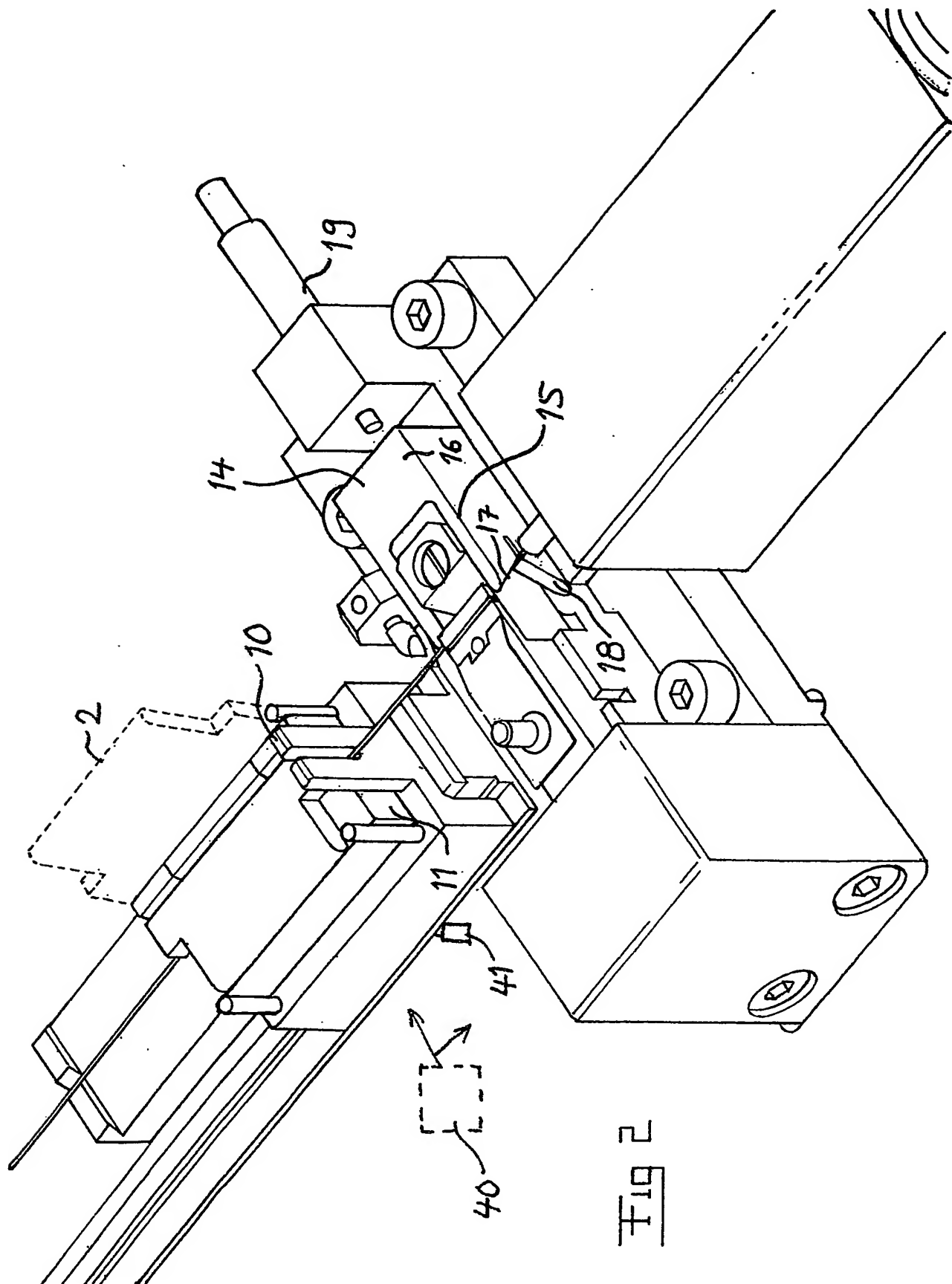
**characterized** in that in said clamping at least one of said clamping members is moved for creating a rectilinear relative movement of said clamping members towards each other for clamping said rod.

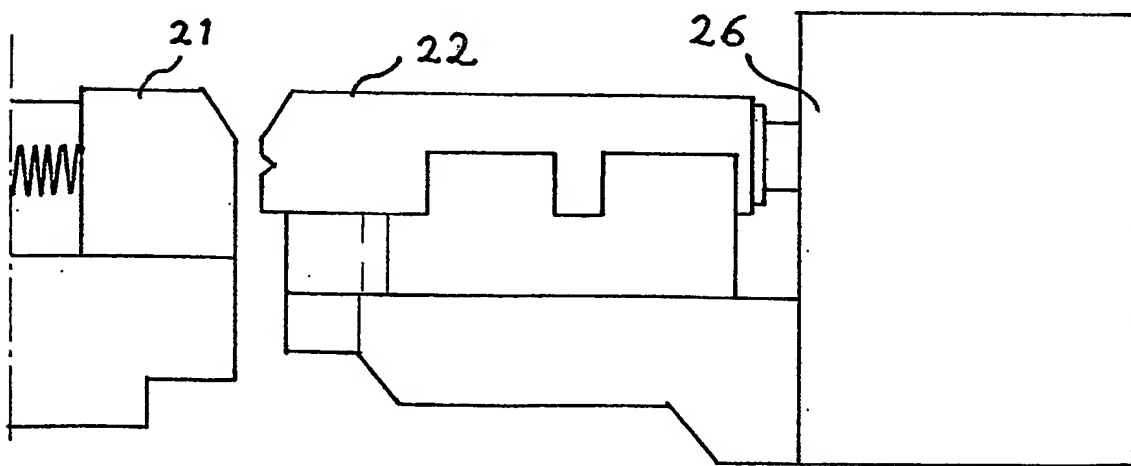
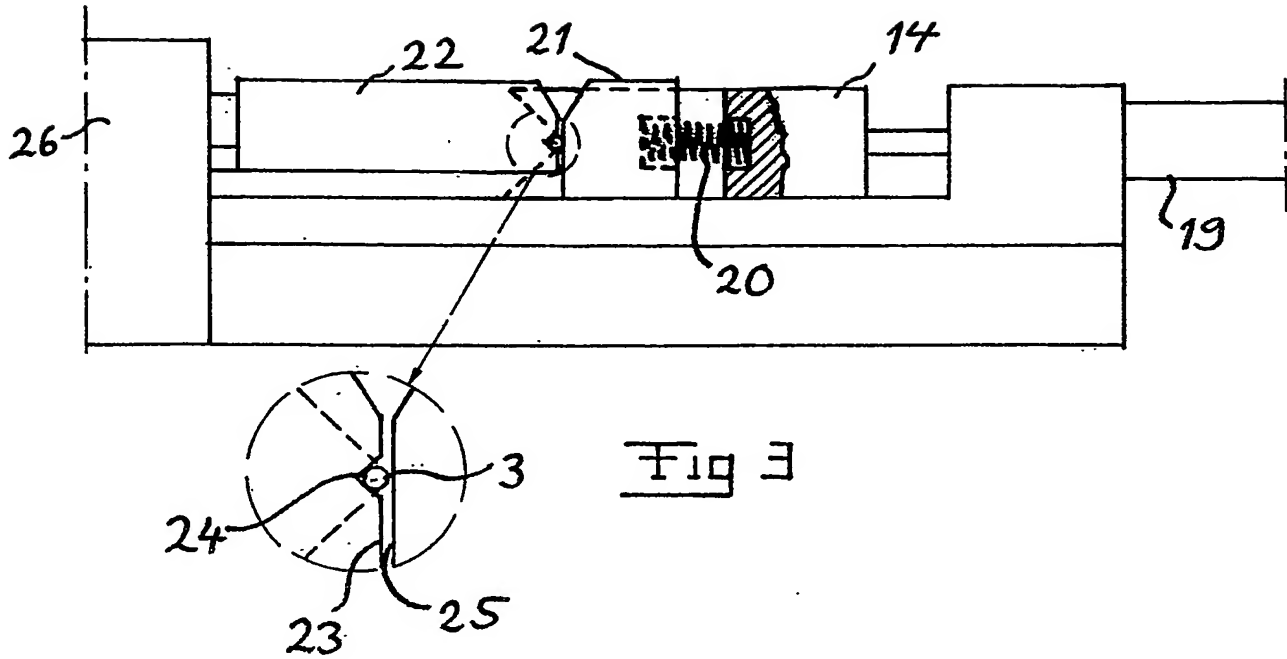
23. A method according to claim 22, **characterized** in that said second clamping member (21) is kept fixed with respect to a framework (45) of an apparatus for cleaving thin rods while moving said first clamping member (22) having the grooved clamp face in said clamping.

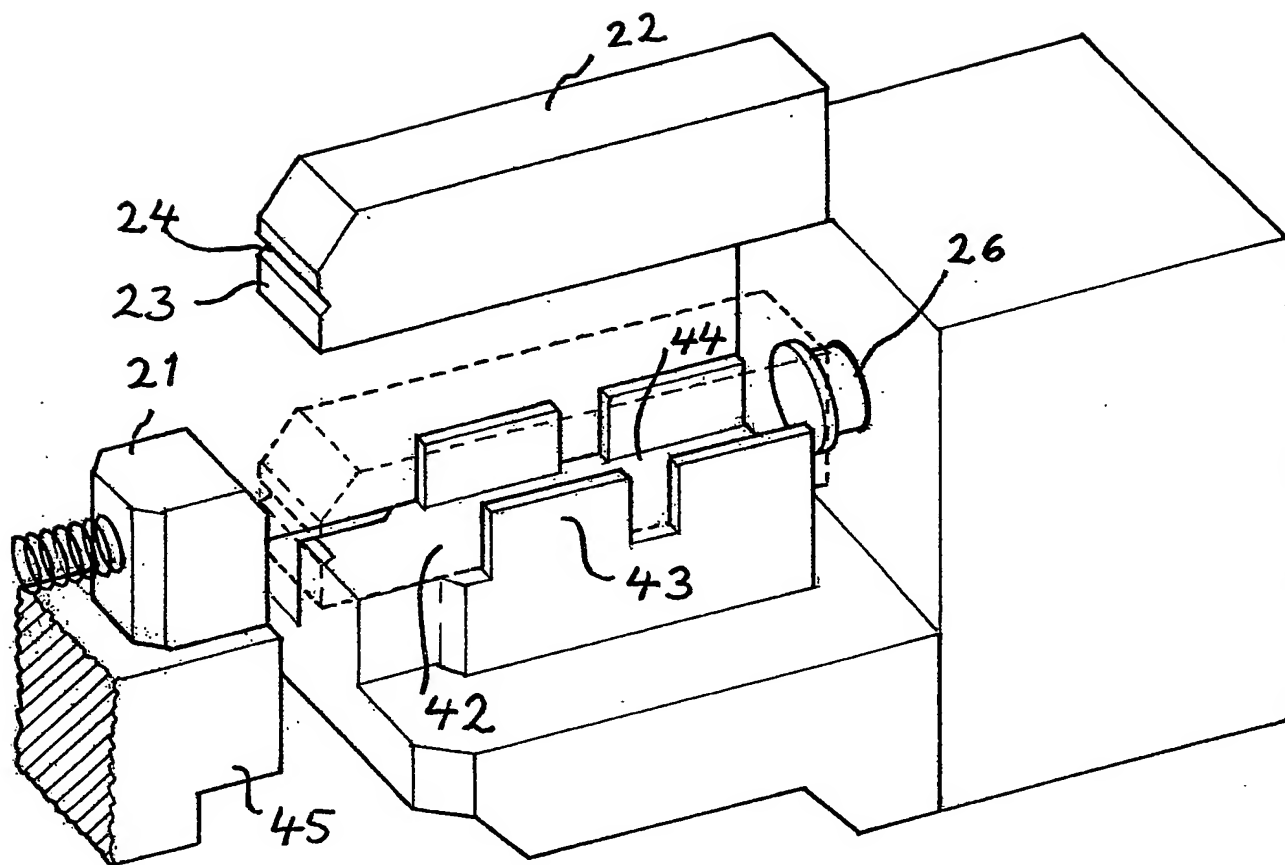
24. A method according to any of claims 21-23, **characterized** in that it further comprises a step of adjusting the position of a rod being clamped in a second of said two clamping locations before clamping it according to said clamping step in the first clamping location, in which at least one member (14) having at least one inclined surface (17, 18) is moved laterally towards said rod with the inclined surface into abutment against the rod for influencing the rod by sliding thereof upon said surface for reaching a position desired for said first clamping location.

25. A method according to claim 24, *characterized* in that in said adjusting step one or more said members (14) having together at least two said inclined surfaces (17, 18), which are oppositely inclined with respect to a plane including said two clamping locations, are moved laterally towards said rod for moving the rod to a seat in an intersection between said two inclined surfaces as seen in the direction from one clamping location to the other.
26. A computer program directly loadable into the internal memory of a computer, comprising software code portions for controlling the steps of any of claims 21-25 when said program is run on the computer.
27. A computer program according to claim 26, provided at least partially through a network as the Internet.
28. A computer readable medium, having a program recorded thereon, where the program is to make a computer control the steps of any of claims 21-25.







Fig 5

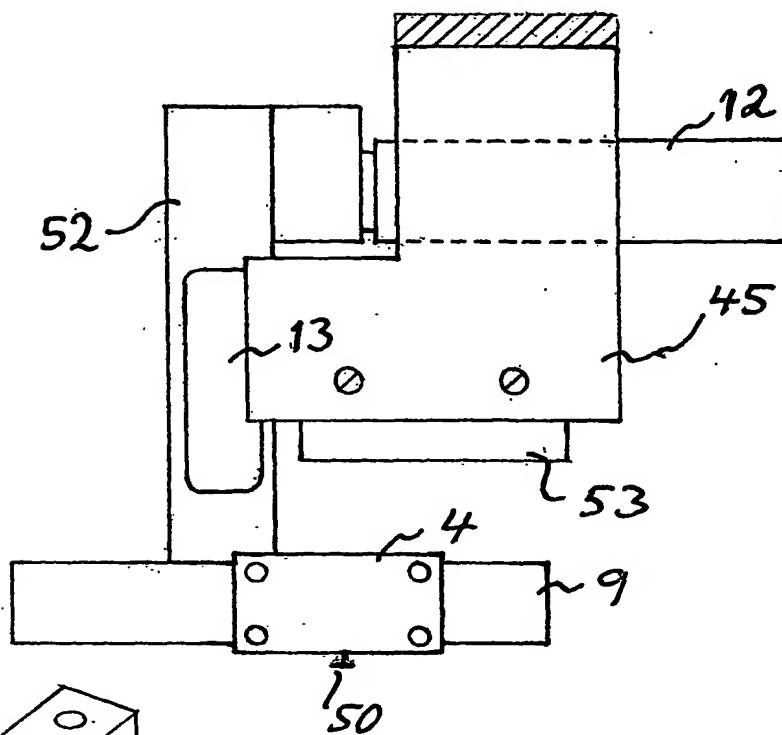


Fig 6

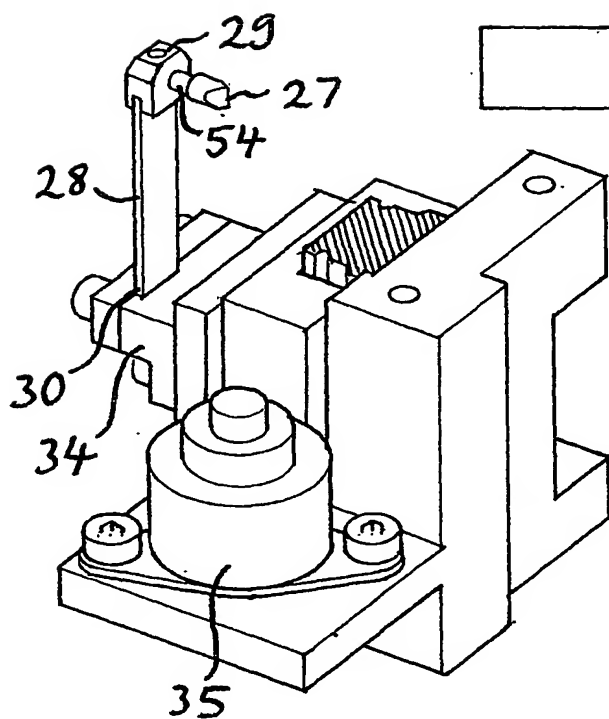


Fig 7

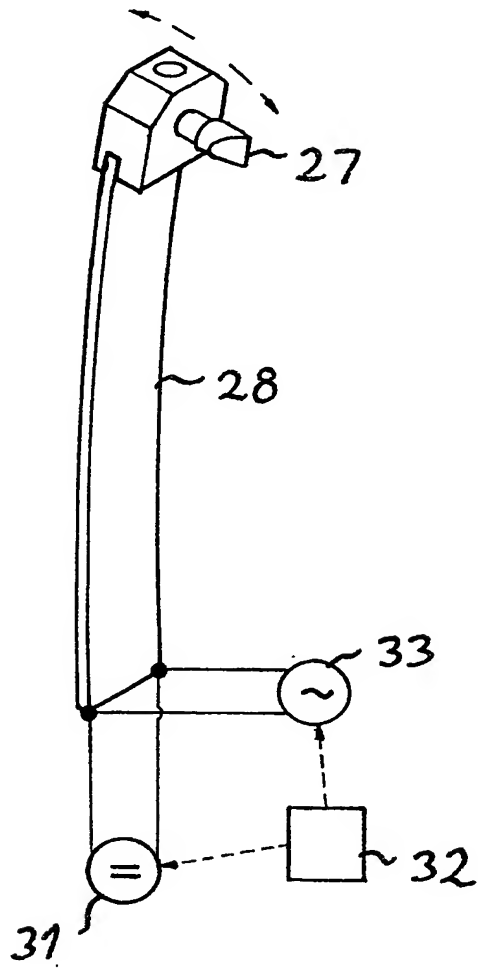


Fig 8

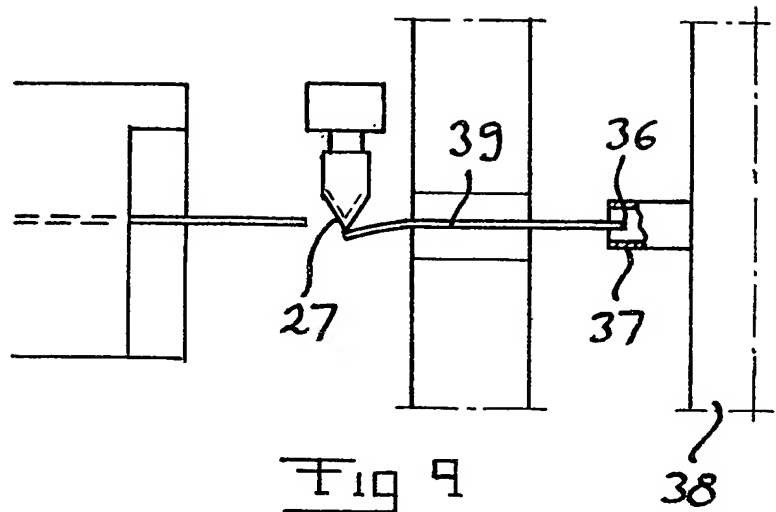


Fig 9

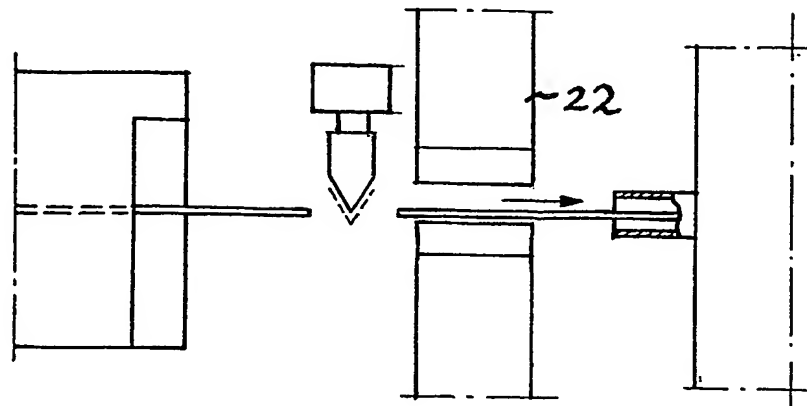


Fig 10



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 03/00950

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G02B 6/25

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5312468 A (HUAN B. YIN ET AL), 17 May 1994 (17.05.94), column 4, line 59 - line 68, figures 10,11  --	1,3-6,10-18, 21,23,26-28
X	GB 2118539 A (WESTERN ELECTRIC COMPANY INCORPORATED), 2 November 1983 (02.11.83), page 2, line 10 - line 124, see the figures  -- -----	2-6,10-18, 22,23,26-28

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

11 Sept 2003

16-09-2003

Name and mailing address of the ISA/

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# INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE03/00950

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

**A first invention according to independent claims 1, 21: a clamping member of V-groove type movably arranged with respect to a framework.**

**A second invention according to independent claims 2, 22: means for creating a rectilinear relative movement of clamping members towards and away from each other.**

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

Information on patent family members

International application No.

PCT/SE 000950

Form PCT/ISA/210 (patent family annex) (July 1998)